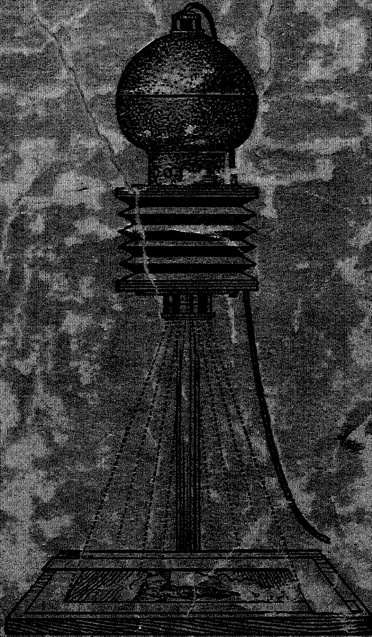
BUILD IT YOURSELF!

Enlargers and Enlarging Accessories



THE GALLEON PUBLISHERS, Inc., New York, N. Y.

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BUILD IT YOURSELF

ENLARGERS

AND

ENLARGING ACCESSORIES

A complete Manual for home built Enlargers of every variety, including miniature and portable enlargers, enlarging accessories, etc. Profusely illustrated with diagrams, photos and working drawings

THE GALLEON PUBLISHERS, Inc.
NEW YORK, N. Y.

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BUILD IT YOURSELF

SECTION I.

THEORY

Many amateur photographers who enjoy finishing their own work have been prevented from making projection prints, or enlargements, because of the price of the equipment. The construction of an enlarger is not at all difficult for anyone handy with tools. If the basic principles of projection printing are remembered there is no reason why the enlarger should not work satisfactorily, with the result that the amateur can have all the benefits and pleasures of low cost enlarging merely by exercising his ingenuity.

It is outside the scope of this book to give minute instructions in the enlarging processes, since they may be found in many good books now available. However, some discussion of the general principles and theory of projection printing will aid in the design of the apparatus.

CHAPTER I.

OPTICAL PRINCIPLES

The enlarger is based on exactly the same optical principle as the camera. In both cases the light from the object is made to pass through a lens and the rays focused on a light-sensitive emulsion. However, the light comes into the camera from outside the chamber which contains the emulsion, while in the case of the enlarger the reverse is true.

The action of the light in both cases is identical. It comes from the source, either natural or artificial, and strikes the object. When this occurs, some of the light rays are absorbed, some reflected and some, if the object is not opaque, pass through completely. These latter rays make enlarging possible. After passing through the negative, they enter the lens. Here they are bent so that an exact re-

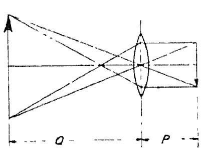


Figure 1

production of the object, called the *image*, is formed on the opposite side of the lens. The image is in focus on a plane called the *focal plane* which is perpendicular to the optical axis of the lens and at a definite distance from it for each position of the object. This action may be seen in Fig. 1.

When the focal length of the lens is known, the position of the image may be calculated from the formula

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$$

where f is the focal length
where p is the distance from the object to the center of the lens
where q is the distance from the image to the center of the lens.

Theoretically, light is reflected from an object in an infinite number of directions. When a point of light passes through a perfect lens, it spatters and takes the form of a circle, called the *circle of confusion*, in all planes except the focal plane in which place it again appears as a point. However, it is impossible to make a perfect lens, so that actually a point of light passing through any lens al-

ways forms a circle of confusion and in the focal plane, a *circle of least confusion*. This latter has the smallest diameter of any of the circles of confusion formed by that point of light. For all practical purposes, in a good lens the circle of least confusion is also a point. As the opening in the lens, through which the light passes, is made smaller, the diameter of the circle of least confusion is decreased. Therefore, an image will appear to be in focus even when slightly behind or before the focal plane. The total amount of light passing through the narrowed lens opening will be decreased and, consequently, in photographic work, the exposure will be lengthened.

The comparative size of the image with respect to the object or, in other words, the number of times of enlargement or reduction of the object, depends on the relative values of p and q which may be calculated by the use of the formula.

$$\frac{I}{O} = \frac{q - f}{f}$$

where I is the desired size of the image
where O is the actual size of the object
where q and f have the same significance as previously.

To use this formula, for example, given a lens of 4 inch focal length with a negative 2 inches long, where an enlargement 6 inches long is desired, the substitutions are

$$\frac{6}{2} = \frac{q-4}{4}$$

which gives a value of 16 inches for q. This means that the lens must be 16 inches from the paper to give an enlargement of the proper size.

CHAPTER II.

ENLARGER DESIGN

From the foregoing discussion, it can be seen that, theoretically, all that is needed to make an enlarger is a light source, a diffusing medium, a lens, and a board or support for the sensitized paper, as represented schematically in Fig. 2. Ac-

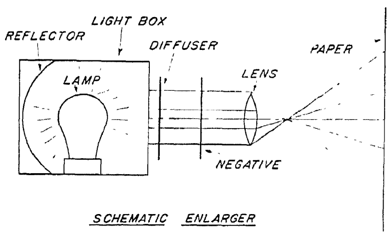


Figure 2

tually, many complications arise which must be taken into account if we are to construct a workable piece of apparatus.

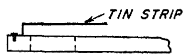
In the first place, the light which comes from the electric light bulb, which we shall consider as our light source, does not all travel in one direc-

tion, but spreads in all directions like ripples on a pond into which a stone has been dropped. The light, therefore, must be confined in some sort of chamber so that there will be only one path through which it can pass out. This chamber may be anything from a simple box to a most complicated affair, depending on the needs of the designer. In any case, it should be light-tight.

It is always a good plan to put some sort of reflector behind the light source, so that the light which would otherwise be absorbed by the walls of the box, may be used to increase the intensity of light leaving through the aperture. The back of the light house may itself be a reflector, as is the case with many enlargers. The best reflecting surface is provided by a light color with a dull finish, which gives minimum absorption and maximum diffusion of light. The internal parts of the light house which do not serve as direct reflectors should also be finished in a light color, preferably white, to prevent unnecessary light absorption.

Enclosing the light produces the very serious complication of heat. Since 90% of the power consumed by an electric bulb is given off as heat, some means must be introduced for allowing it

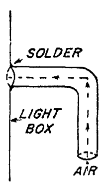
to leave the light house as fast as, or faster than it is generated. If no provision is made for this, the whole apparatus may get hot enough seriously to damage the negative, if not the enlarger itself. It is therefore extremely important to provide adequate ventilation. Failure to do so is too common a fault in most home-made enlargers. Since the circulation will be entirely natural (no fan or other mechanism forces the air through the light house),



TIN STRIP BAFFLE

Figure 3

there will be very little to impede the air flow. At the same time, no light should be allowed to escape through the vent openings. This necessitates a compromise, insofar as the air path is concerned.



BENT COPPER TUBE

Figure 4

The simplest type of ventilator consists of holes in the lamp house, covered with bent metal to act as baffles. The light, since it travels in straight

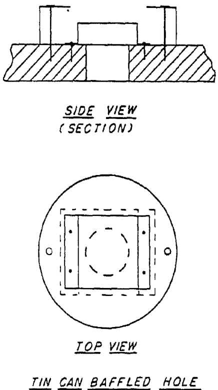


Figure 5

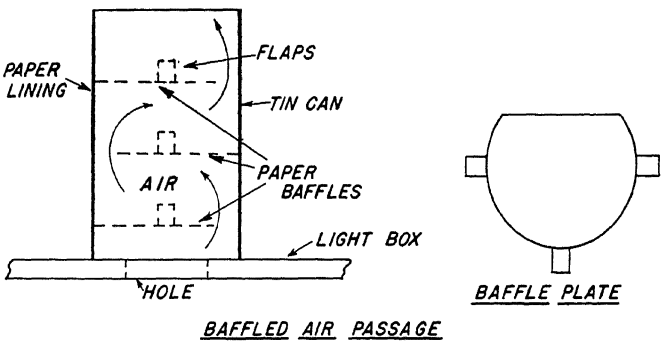


Figure 6

lines, is more or less prevented from leaving, while the air passage is practically clear. This tin strip baffled ventilator is shown in Fig. 3.

A comparable method for metal walls consists in soldering a bent length of tube to the side of the lamp house, as shown in Fig. 4. A better type, the tin can trap pictured in Fig. 5, works very well, while a more complicated but much more efficient trap is the baffled passage constructed from a tin can and black paper, according to the design shown in Fig. 6.

The inside of the ventilators must be treated to yield a dull black surface that will absorb light which might otherwise be reflected. The size of the ventilators depends on the amount of heat generated by the light source. This, in turn, is determined by the wattage of the bulb. Therefore, the size of the vent holes can be calculated from the rating of the bulb used. A fairly good empirical rule to follow in designing the ventilators is to allow at least one square inch of inlet and one square inch of outlet for each 100 watts consumed. The total inlet and outlet area needed for a 150 watt bulb would be, consequently, not less than three square inches. To facilitate a natural circulation the inlet should be below and the outlet should be above, the bulb.

The size of the bulb which is to be used in the enlarger depends on the speed of the lens and the approximate length of exposure desired. Exposure should be slow enough to permit dodging and other printing tricks, though sufficiently fast to prevent tedious waiting. The exact length of exposure of a given bulb can be varied by the diaphragm opening on the lens, within the limits imposed by the density of the negative. In most cases a 60 or 100 watt lamp is satisfactory, although for very dense negatives a No. 1 Photoflood bulb may be used. The heat liberated by a single Photoflood bulb in fifteen minutes, however, is sufficient to boil one and one-half pounds of water whose temperature initially is 70°. Hence, to maintain a workable temperature, an extremely efficient system of ventilation must be employed. A dimmer, which puts additional resistance in series with the lamp, is usually attached when a Photoflood is used to allow focusing without excessive light and heat, and prolong the life of the bulb.

Light emitted from a concentrated source does not spread with uniform intensity over a flat field. Consequently, where even illumination is desired, as is sometimes with a camera and always with an enlarger, some diffusing medium must be used

between the light source and the object. By this means the intensity of illumination over the complete area can be made uniform. The diffusing medium may be of flashed opal glass or ground glass, either of which if placed rather close to the bulb will still perform satisfactorily. This medium has an advantage over condensing lens systems in that a separate focusing of the diffuser is not necessary each time the picture size is changed. However, double lens systems are out of our province here, since the addition of a second focusing device complicates a design altogether too much for home construction.

To prevent damage when glass is mounted in a support where it might be exposed to heat, plenty of room should be allowed for expansion of the glass.

The exit aperture in the light house is made on a side in a horizontal enlarger, or on the bottom in a vertical enlarger, and its size is determined by the maximum negative to be used. The aperture should be slightly larger than the area of the negative, so that the light will completely cover the area to be projected. The negative is held directly in front of, or below, the aperture,

depending on whether the enlarger is horizontal or vertical.

All holders can be classified either as drawer arrangements or tracks. The drawer type is simply a frame provided with a strip around the bottom to prevent the negative from falling through. This frame slides into an extension below the lamp house. The track is usually designed so that a strip or roll of film may be slid into position, either supported by the track alone or by glass plates.

There are five main points to remember when designing any type of carrier. First, it must be suitable for the negative sizes most used, that is, the amateur who intends to work with plates should not make a carrier which is primarily intended for roll film, and vice versa.

The second point to remember is safeguarding of the film. Any small scratches on the negative will ruin its suitability for enlarging. It is therefore important to remove all rough edges and sharp corners which are likely to come in contact with the film. No holder in which the negative is apt to be bent, scratched, or exposed to excessive heat should ever be used. Some provision must also be made for supporting that part of a roll of film which is not being projected.

The third specific consideration is the immobility of the negative during exposure and, in fact, of the complete projector. If any part of the setup (the light, negative, lens or easel) moves during exposure, the print will be ruined. The carrier, therefore, must hold the negative firmly in the desired position. This may be done by the use of springs or by the weight of a sheet of glass resting on the negative. Out of this latter usage comes the next point.

When an enlargement is made, all marks, both on the negative and on that part of the carrier within the aperture, are clearly seen on the print. Therefore it is of the utmost importance to keep the glass in the negative carrier clean, and free from finger prints and dust. The ease with which the glass may be removed for cleaning helps determine the value of an enlarger.

The last pertinent point concerns proper negative adjustment in the carrier. This must be so constructed that the negative can readily be shifted about, so that the portion of the negative which is to be projected will appear in the region of the aperture available for exposure. It does not matter if undesirable portions of the negative are projected as well, since the paper can be masked

if a margin is desired, or simply trimmed where a border is necessary.

The ease with which the negative may be placed in the enlarger determines, to a large extent, how much time will be spent in making each print. If a drawer arrangement is to be used, that portion of the glass which comes within the available exposure region should be marked by lines or by a mask. In this way the position of the negative projection on the easel can be determined immediately. With a spring-held negative, the position may be determined by moving the negative or glass protection plates after insertion in the carrier *if* care is taken that they suffer no damage during the process. Miniature enlargers are usually so constructed that the whole of one frame is in the region of exposure, and therefore it is unnecessary to move it once it is placed in the carrier.

The lens itself may be mounted in several ways. Should the whole camera be used, the focusing device already present obviates the necessity of

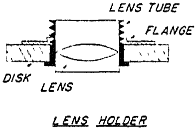


Figure 7

constructing another. If only the lens is used, it may be obtained from an old camera or purchased separately, and fastened to a telescoping tube by means of the flange on the lens mount, as shown in Fig. 7. This is quite simple, since all that is needed on the tube which holds the lens is a disk with a hole of the proper size to accommodate the lens mount. The material of which the disk is made is inconsequential so long as it can be fastened firmly in place, holds the lens securely and is cut accurately, so that the optical center of the lens is directly in a line drawn from the filament of the bulb to the center of the negative. Inaccuracy will result in an enlarger which cannot be focused sharply.

The distance of the lens from the negative must be determined by the formulæ given previously. This distance will not be fixed since the size of the pictures will not be constant; but the maximum and minimum distances must be determined before the focusing device is designed. The enlarger must, therefore, be built for a lens of definite focal length. To obtain enlargements of practical size when a camera is used as the lens assembly, the negative must be somewhat behind its mormal position in the camera.

Of the lengths of tubes composing the focusing device, the one which carries the lens should be a little longer than that which is fastened to the enlarger. In this way the lens may be brought closer to the negative, with the same length tubes, and a larger picture may be obtained.

The tubes can be held in proper focal position either through friction or by more positive means, such as a rack and pinion. These must be firm enough to prevent undesirable motion, which will ruin the print. Accurate focusing, however, must not be sacrificed for rigidity.

The complete assembly from the light house to the lens, forms the projector which may be mounted with either a vertical or horizontal optical axis. The suitability of either type depends on the needs of the photographer.

Horizontal enlargers can be used where large prints are desired, since the wall of the dark room can serve as a support for the paper, thus increasing the distance q as noted in the formulæ. This, however, is almost the only advantage of the horizontal type. The vertical type of enlarger is much better adapted to the requirements of the amateur, since it is easier to work with and needs less room. The paper can be put on a tablelike surface where

no difficulty is met with in holding it firmly in place.

Since motion is only relative, it makes no difference whether the distance from the lens to the negative is changed by adjustment of the easel or of the projector. The only strict requirement is that once the position of the movable part has been determined, it must be secured firmly.

There are many ways in which the projector may be mounted in a vertical enlarger. It may either be fastened to a sliding frame or connected by an adjustable arm to a pipe, along which it slides. There may also be a system of horizontal bars which are fastened to a wall or similar support, and are free to rotate in a vertical plane. In fact, the methods of support are limited only by the inventiveness of the builder. The same may be said about easel mountings. It is necessary, however, to have a positive fastening in any desired position.

To prevent motion of the projector and consequent blurring of the print, the exposure should be controlled by an electric switch, and not by the shutter, if there is one on the lens assembly. The switch should be on the line leading to the enlarger

or, preferably, controlling the outlet from which the enlarger receives electricity. This will minimize the danger of motion when starting and finishing the exposure.

SECTION II

PRACTICE

It is best to lay out a full scale drawing of each part before any actual construction of an enlarger is started, so that there will be as little waste of materials as possible. These drawings should be accurate, so that the method of fitting together the various parts can be easily seen. Any paper may be used, since the drawings are not for show purposes. Heavy wrapping paper is quite suitable. A list of materials and tools needed also expedites the construction.

In the following pages are plans and descriptions of enlargers which have been designed and constructed by amateurs. The principle previously enumerated have been adhered to, except in cases where obvious compromise was necessary.

CHAPTER III.

SIMPLE CONSTRUCTION WOOD ENLARGER

The easiest enlarger to make is a horizontal type in which the lamp house is simply a box, and a camera is used for the lens assembly. This avoids the construction of vertical sliding supports and complicated focusing mechanisms.

We will start with the assumption that there is available, a 120 Eastman camera with a removable back, which we will use as the lens assembly. The first things we will make, after we have designed the enlarger, are the full-scale drawings on wrapping paper. The tools and materials needed are as follows:

TOOLS

hammer
screw driver
wood and metal drills
vise
saw
protractor or adjustable miter
tin snips
small paint brush

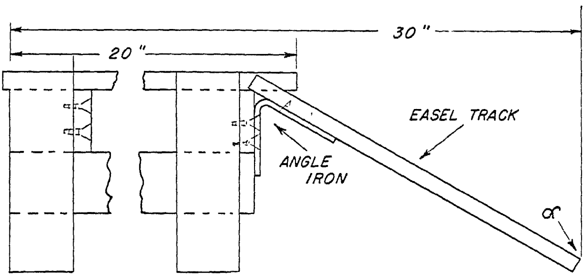
large paint brush
scissors

MATERIALS

1 flat hook
1 Photoflash reflector
1 frosted 100 watt bulb
1 fixture socket
electric cord
base plug
screws
tin sheet 38″ x 1¾″
4 angle irons (2″ arms)
felt
glue
wood ½″ x 2″ x 190″
⅜″ ply wood 16 x 36
drawing board 15″ x 20″
2 hinges
2 C clamps
1 camera

This enlarger will have a stationary projector and movable easel. Since the whole apparatus will be mounted on one supporting stand, it would be best to build the stand first. We have to make some preliminary calculations, however, to see what the angle *L* in Fig. 8 should be. This depends on

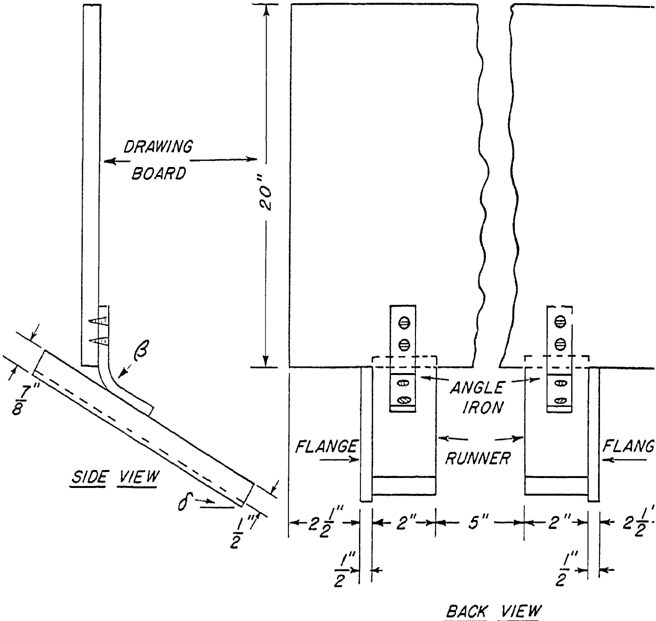
the focal length of the lens in the camera. By finding the projected length of the easel track, which we have shown in Fig. 8 as 10″ (30 minus 20), we can determine the actual length. The projected length is the distance q as given in the lens formulæ. The actual length is found by plane geometry, using the Pythagorean principle ($a^2+b^2=c^2$). The angle L in Fig. 8 and B and S in Fig. 9



SIDE VIEW OF TRACK AND SUPPORT

Figure 8

are all determined from the resulting right triangle. We will assume here that L is 60°, which makes B 120° and S 30°, since L plus B must equal 180° and $L + S$ must equal 90°. It is of great importance that these angles be accurately constructed, since otherwise the complete area of the projection will not be in focus.



DETAIL OF EASEL ASSEMBLY

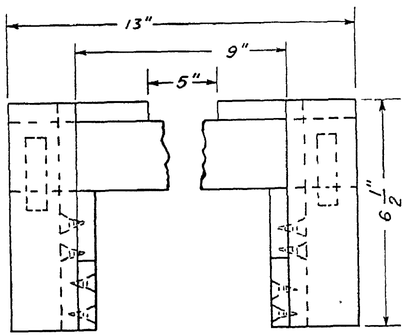
Figure 9

Construction will start with the table, which is made of ½" x 2" wood throughout. The details for this can easily be seen from Figs. 8 and 10. The purpose of the supports are to prevent vibration and unsteadiness. This assumes that the legs are all cut to the same length, since no amount of

bracing can prevent motion if one leg is of different length than the others.

The easel, Fig. 9, consists of a drawing board held in position by runners made of 2″ wood, having flanges fastened to the side to provide added support, as may be seen in the figure. The angle irons used will have to be bent to the proper angle since they come only at 90° and 180°.

Now work can be started on the projector. The front frame which supports the camera is made



END VIEW OF TRACK AND SUPPORT

Figure 10

of ½″ wood and plywood. The ½″ x ½″ bars are cut to provide two 7″ and two 4″ lengths. Grooves must be cut in the two long pieces and in one of the short pieces to allow the camera to

slide in and out. These four strips are then fastened together to form a frame from which the long pieces project to provide legs, as shown in Fig. 11. The top piece is not fastened, so that the camera can be inserted.

Next the sheet of plywood is cut to provide two pieces 5″ x 6″ and one 5″ x 4¼″. The 5″ x 6″ pieces are fastened to the sides of the frame and the remaining piece, with the corners cut out, to the bottom of the frame where the legs protrude.

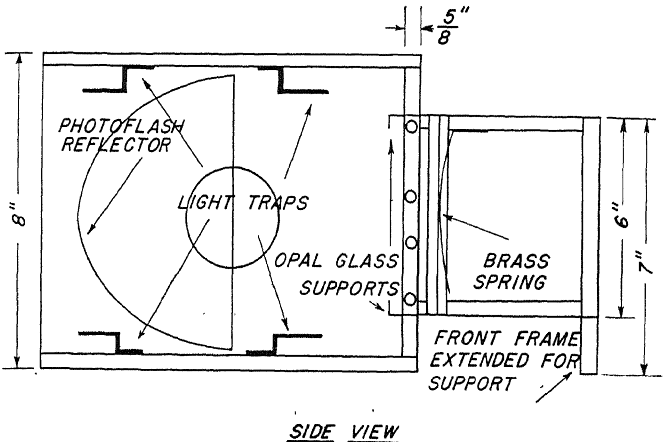


Figure 11

The negative holder which also fits in the box, is made of two brass strips, cut to the size and shape shown in Fig. 12 and assembled as in Fig. 13.

A piece of plywood $4\frac{1}{4}'' \times 4''$, fastened to the top of the extention box, completes the front.

The other end of the box is fastened to the light house proper. The same screws which hold it in position also hold the opal glass supports

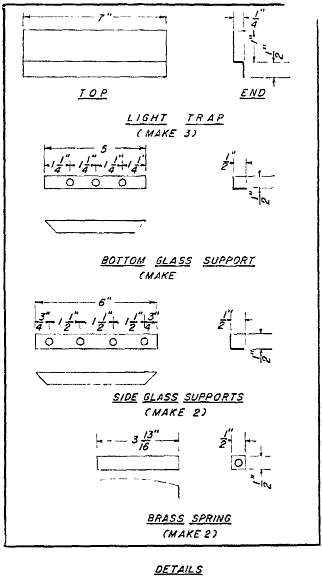


Figure 12

in place, so they must be made next, according to the dimensions shown in Fig. 12. The reason for making the top of the box shorter than the

rest can now be seen, since that is where the negative will be inserted. There is a short strip of plywood on the other side of this opening to make the assembly as light-tight as possible and give a more finished appearance.

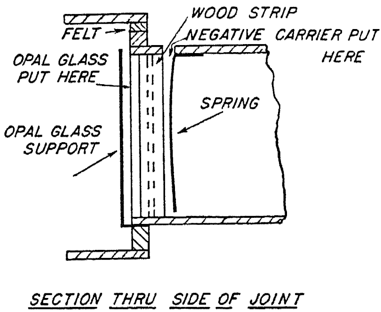


Figure 13

The lamp house proper is also a box, made of plywood. The sides and top, which is hinged, are 8″ x 10″, and the bottom is 7¼″ x 10″. One side has a hole for the socket, placed so that the light, when in position, will be on the optical axis of the lens. This may sound difficult to do, but by laying the dimensions out on paper first, the exact position of the hole can be determined. This measurement cannot be given here, because it depends on the type of socket and reflector used.

There must be some kind of supporting frame at the corners, since plywood is not strong enough to make a firm joint. The support for the rear end of the box consists of two bars of wood, ½″ x ½″ x 6¼″, placed vertically in the corners. The front frame, which will also support the

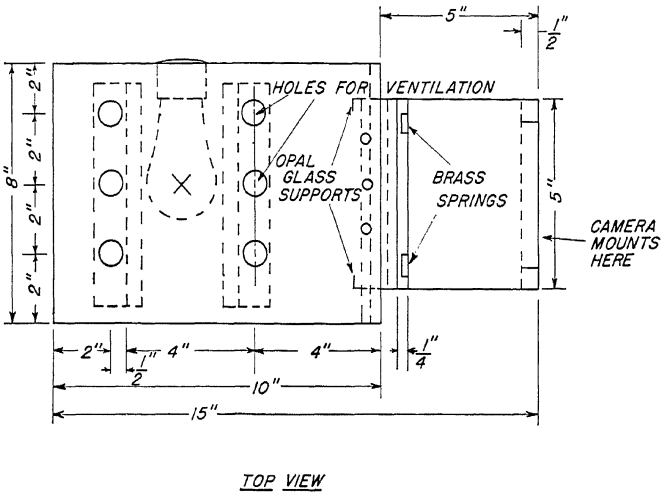


Figure 14

extension box previously made, consists of two bars of ½ x ½ x 7¼″ and two of ½ x ½ x 3¼″, put together. These may be seen in Figs. 11, 13, and 14. The back of the box is plywood, 6¼″ x 7¼″.

The final steps before assembly consist of making the light traps, which are the simplest tin plate type, and drilling the holes for ventilation in the top and bottom of the light house. There should be six ½″ holes in the top, and an equal number in the bottom, spaced as shown in Fig. 14.

After this is done, the projector may be assembled. It will be seen that there is an overlap of ¼″ where the sides of the light house extend past the bottom. This forms the base on which the projector stands, and allows a space for ventilation.

The inside of the lamp house should be painted

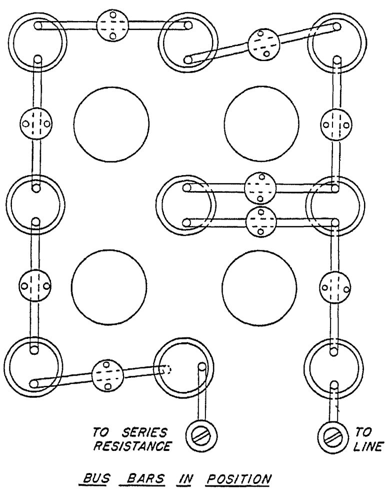


Figure 15

white and the inside of the extension box, black, to prevent internal reflection. The outside may be any color desired. The negative carrier consists of two glass plates, between which the negative is placed. This enlarger will not take rolls of film, but can be used for short strips or individual negatives.

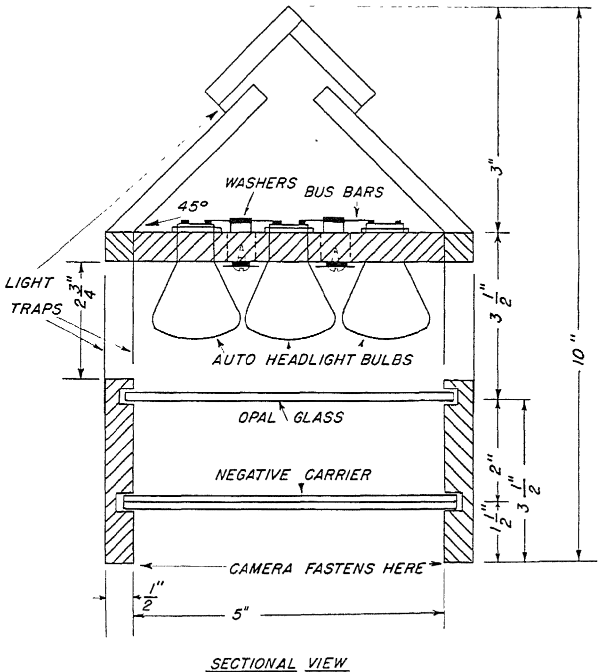


Figure 16

For those who want a vertical enlarger with a camera for the lens assembly, a very satisfactory device can be made with nine double filament, 21 and 21 candlepower, 6 to 8 volt automobile bulbs. These are wired in series, as shown in Fig. 15. Since both filaments are connected to the brass base, they will light when 12 to 16 volts are supplied, if the base is insulated and connections are made across the two contact points. When placed in

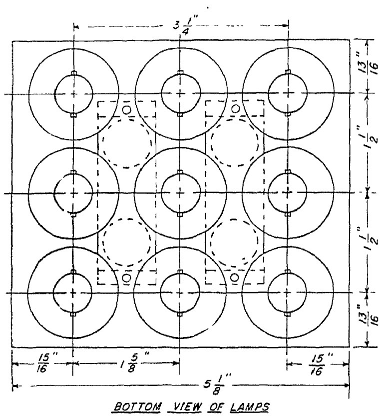


Figure 17

series with 110 volts applied, there is a drop of 12.2 volts across each bulb, well below the safe limit. The bulbs are mounted on a block of wood ½″ x 5⅛″ square, or any other insulating ma-

terial with comparable strength and the same area. The bus bars, or electrical connections between the bulbs, are brass strips held above the board by washers, and arranged as shown in Figs. 15 and 16. Ventilation holes drilled in the board are protected by tin strips to prevent light leakage and dark spots in the field. The strips on the opposite side of the board from the contacts, are also held off its surface by washers.

For both the bulbs and ventilation, the holes should be located as shown in Fig. 17. The bulb holes should be 19/32″ in diameter, and the vent holes ¾″ in diameter. The filament side of the board should be covered with aluminum paint or some other reflecting surface, but care must be taken to see that there is no contact between the bulb bases. The importance of this cannot be overstressed because any path of electrical conduction will cause a short circuit which, in all probability, will burn out the bulbs as well as the house fuses.

The sides of the projector form a new type of ventilator not previously described. A plate is fastened to the top section and one to the bottom section of the lamp house, which, when put in position, form the ventilators as shown in Figs. 16 and 18.

The top ventilator consists simply of two pieces of wood arranged in an inverted trough and held above the roof by an extension, on two sides of the box, with the openings running along the other

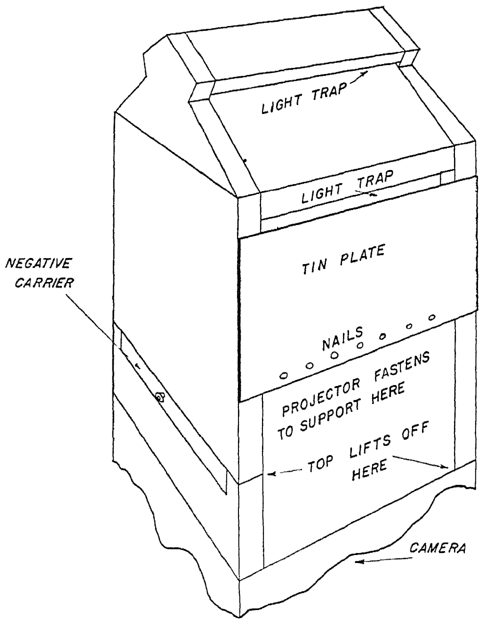


Figure 18

two sides. The construction of this can clearly be seen from Fig. 18.

By lifting the top ventilator, the whole top section, consisting of the roof, the bulb board, the

inner light baffle and one side, lifts off. This allows easy access to the bulbs, to replace burn-outs. The faces where the sections come together are covered with felt to prevent light leakage.

Since all the bulbs will go out when one filament breaks, it will be necessary to have an extra bulb on hand to replace any defective one. The method of finding a defective bulb is to start with one bulb, working around the circuit, replacing each bulb by the one before it, and turning on the current after each change. When the defective bulb has been replaced, the lights will go on. If the lights do not go on when all the bulbs have been replaced, test each one separately with a storage battery.

The negative carrier is of the drawer type and consists simply of a drawer which slides into slots below the opal glass. The camera is fastened to the two sides, which do not lift off with the top, and to part of the third where the negative carrier fits in. This forms enough of a frame to hold the remainder of the assembly. The camera must be firmly fastened to the projector to insure rigidity.

Since the dimensions as given on the drawing are intended only to give an idea of relative proportions rather than to be actual fixed quantities, there would be no sense in giving detailed in-

struction for cutting the parts. These must be determined by the size of enlarger wanted, and by the size of the camera at hand.

The projector is fastened to an automobile piston rod which can be purchased at any junk shop. The bolt in the small end is replaced by a wing nut and bolt which, to a small extent, allows the diameter of the hole to be regulated, thus clamping the rod to the pipe on which it slides. The pipe is ordinary

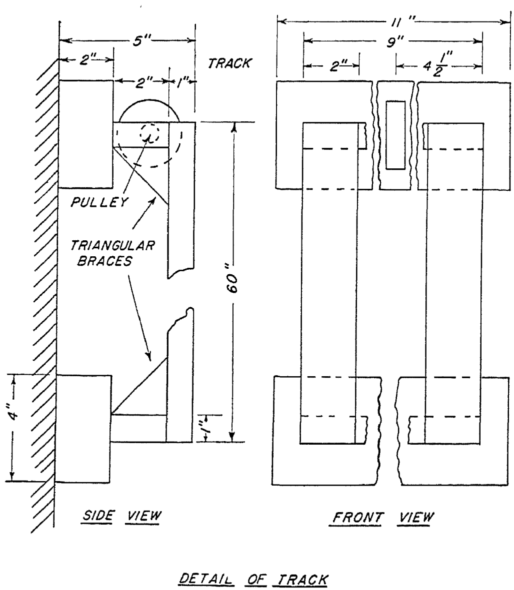


Figure 19

galvanized iron, with a floor flange fastening it to the easel. This is a fairly common type of assembly, and will be explained in more detail later.

If a permanent dark room is available, it may be desirable to fasten a vertical enlarger permanently to the wall. There are quite a few which have been designed for this. One, which moves on roller skate wheels, is rather easy to make. The track itself is nothing more than two strips of wood, 2″ x 1″ x 60″. These are mounted on cross strips 2″ x 1″ x 9″, one of which contains a slot for a pulley. The corners are braced by triangular blocks which can be made by cutting a rectangular block in half, diagonally. The assembly is then fastened to blocks 2″ x 4″ x 11″, which have previously been fastened to the wall. The method of assembly is seen in Fig. 19.

The easel can be a table or a board fastened to the wall below the projector. It is not movable and therefore can easily be constructed without further directions.

The first piece to be made is the top ventilator. This is a tin can of about 3″ diameter, with the top and bottom cut out. A piece of this tin is cut to form a square 6¼″ x 6¼″, with a hole, in the exact center, whose diameter is not more than ⅛″ smaller than that of the can. The can is then

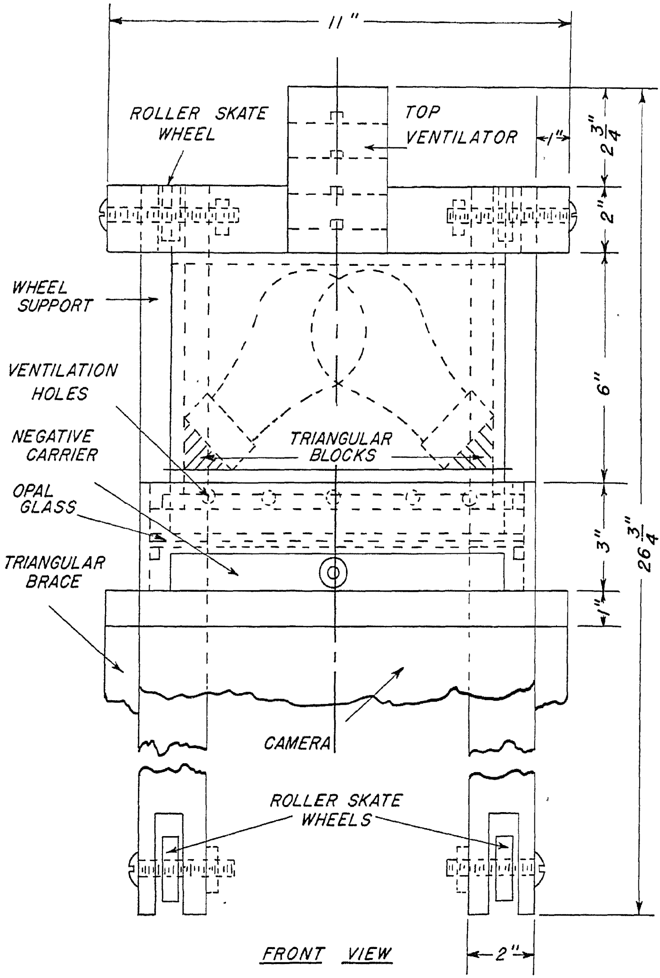
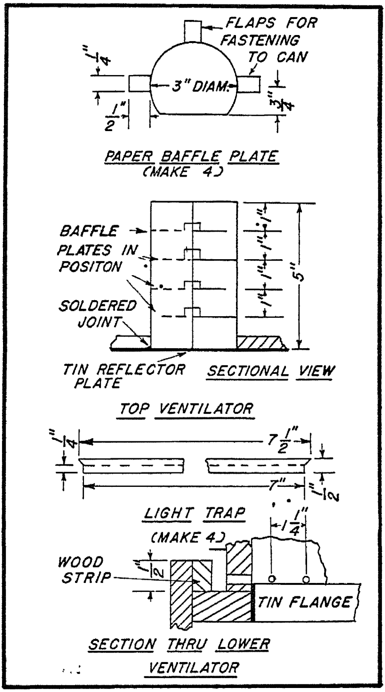

11"
ROLLER SKATE WHEEL
TOP VENTILATOR
1"
2 3/4"
2"
WHEEL SUPPORT
VENTILATION HOLES
NEGATIVE CARRIER
OPAL GLASS
TRIANGULAR BLOCKS
TRIANGULAR BRACE
6"
3"
1"
26 3/4"
CAMERA
ROLLER SKATE WHEELS
FRONT VIEW
2"

Figure 20

soldered to the plate. After this, a piece of plywood, 7″ square, is cut and drilled to allow it to fit over the can and rest against the plate. This forms the top of the lamp house. The sides of the house are made from two pieces of plywood 6⅛″ x 6¼″ and two 6⅛″ x 7″, which are drilled



DETAILS

Figure 21

around the bottom to provide vent holes 1/4″ in diameter and 1/4″ from the bottom, as shown in Fig. 20. Small triangular pieces of wood, which may be found in almost any shop, form the corner braces by which the completed box is held together.

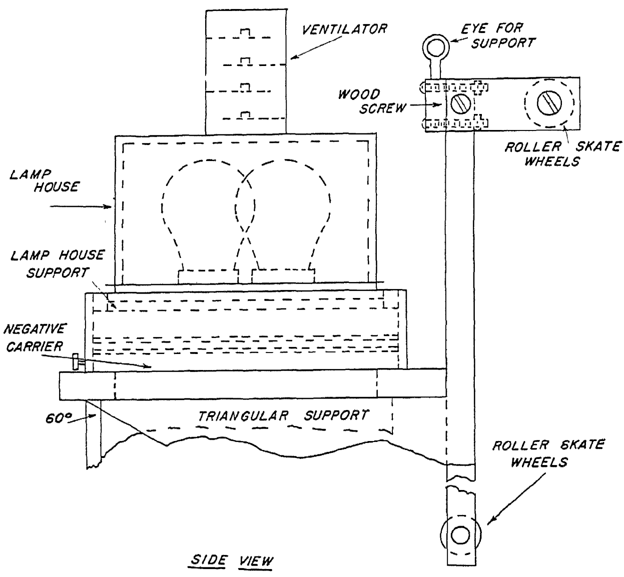


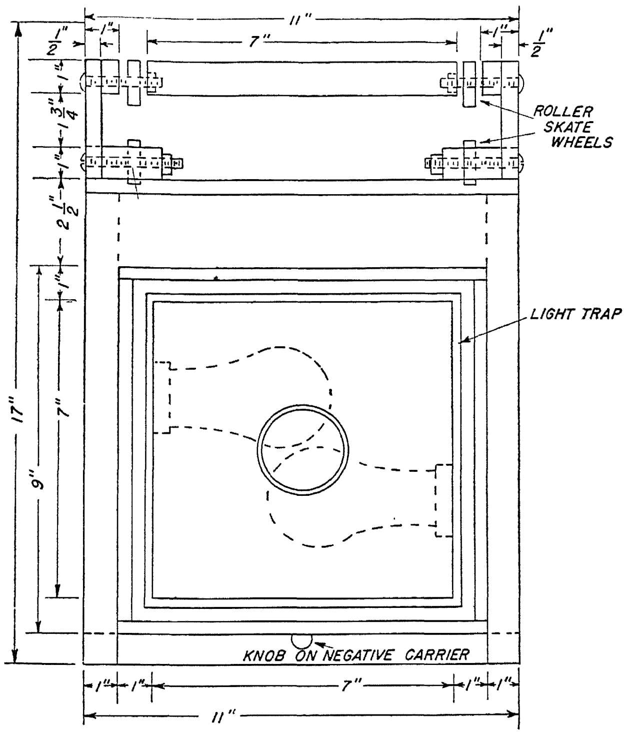
Figure 22

The tin plate is fastened firmly to the inner top of the box to form a reflector, and the inside of the light house is painted white.

The upper ventilator is formed by lining the

can on the top with black paper, and pasting in baffles shaped as shown in Fig. 21.

Porcelain or bakelite electric sockets, of the type used on electric signs, are fastened to triangular blocks and put into position in the corners of the



TOP VIEW

Figure 23

light house, as shown in Figs. 20, 22, and 23. In this way, larger bulbs can be accommodated and the light will still be uniform in intensity.

The final step necessary to complete the lamp house consists of fastening tin strips around the outside, just above the lower ventilation holes, to serve as baffles. These are cut as shown in Fig. 21, and bent at right angles down the center line. If the angles have been cut correctly, the corners will fit exactly. These strips should extend out for 1/4″ at a distance of 1″ from the bottom of the box. The lamp house can now be painted.

This box is held in position by a frame 8 1/4″ square made from wood 1/2″ x 1″, two pieces of which are 6 1/4″ long, and two 8 1/4″ long. A smaller frame of wood 1/2″ x 3/4″ is fastened inside this, flush with the top, to form a light trap and ventilator. A detail of how the ventilator is formed of these parts is shown in Fig. 21. The outer frame is now covered on all four sides with plywood, flush at the top but projecting below to form the box for the negative and opal glass. The individual pieces for this box are two pieces of plywood 3″ x 9″ and two strips 3″ x 8 1/4″. Centered on the bottom edge of one of the shorter of these pieces, a strip is cut 6″ long and 1″ wide, to form an opening for the negative carrier.

When all but the cut section have been fastened into position by means of corner blocks, strips are put outside, as far up as practicable, to support the opal glass. The front view may be seen in Fig. 20. Since the glass will be enclosed by the box, the side which has been notched should be fastened by screws so that it can be removed to allow insertion and replacement of the opal glass.

A flange of tin 1″ wide is now fastened around the inside of the frame to hold the lamp house firmly in position. This also may be seen in Fig. 21.

The bottom of the negative support box is fastened to and rests on a frame 12½″ x 11″, which has three sides of 1″ and one side 2½″ wide. The wood used for this should be 1″ x 2″. The individual pieces consist of three 11″ and two 6½″ long. To make the thick side, the two short pieces are fastened together to give an effective width of 2″. This is shown in Fig. 23. The negative support box is now fastened firmly to this frame. When the camera is fastened to the underside of the frame, the projector is completed, except for the negative carrier which consists of a printing frame with the back removed, and in which the negative is held betweeen two plates of glass.

The support which holds the wheels and fastens to the projector consists of two pieces of 2″ wood, 24″ long. Slots are cut in the bottom of each piece, just wide enough to allow the insertion of roller skate wheels, as shown in Fig. 20. The other ends of each piece are fastened together by a strip of wood 2″ x 11″. This overlaps at the sides for a distance of ½″, spacing the long bars 6″ apart.

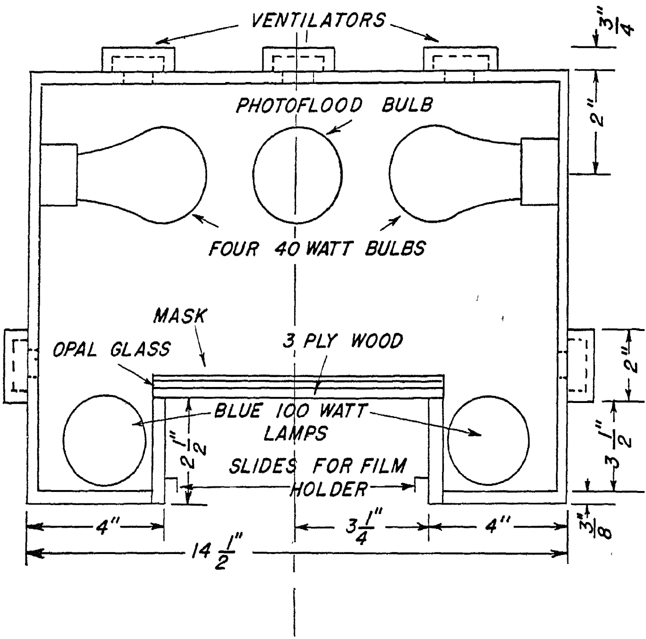


Figure 24

The eye for supporting the enlarger goes in the center of this spacer, as shown in Fig. 22.

The assembly for holding the top wheels is made from one length of wood 11″ x 2″ x 1″, two blocks, and two pieces 3¾″ x 2″ x 1″. The long piece has holes inlet at each end to hold bolts. The complete assembly is shown with sufficient clarity in Figs. 20, 22 and 23 to make further description unnecessary.

The projector is to be fastened 12″ from the top of the bar supports. It is held rigid by two triangular braces 7″ x 11″ placed on the edges, as shown in Figs. 20 and 22. All these are fastened in place by screws.

It will be seen that the top wheel assembly,

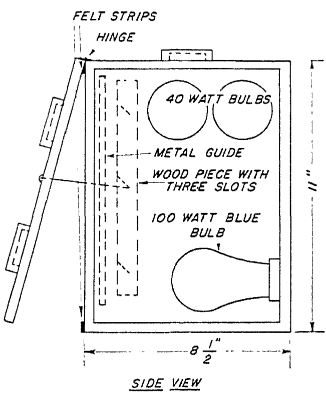


Figure 25

which cannot be put on until after the projector has been placed against the track, holds the projector in place. Therefore, if the connecting bolts are not tight the projector may fall off. If all has been done correctly, however, the only motion possible will be in a vertical direction. A rope from the eye on the movable support and over the pulley on the track serves to adjust the height of the projector, whose weight should be counterbalanced by a bag filled with sand or similar material so that the projector will remain stationary at any position on the track. It is then easy to hold the rope so that the projector will not slip during exposure, since no weight is actually held by the fastening.

A vertical enlarger (Plate 1,) with the same general idea but with the advantage of indirect and stronger lighting as shown in Fig. 24, is also easy to construct. Indirect light is an advantage because the light, by being reflected, is more diffused than if a diffuser alone is used.

The light house is again a simple box, the construction of which may be determined with little or no trouble from the plans. The wood through out is 3/8″ stock. Since all necessary dimensions are given on the plans, Figs. 24 and 25, there is no need for repetition here.

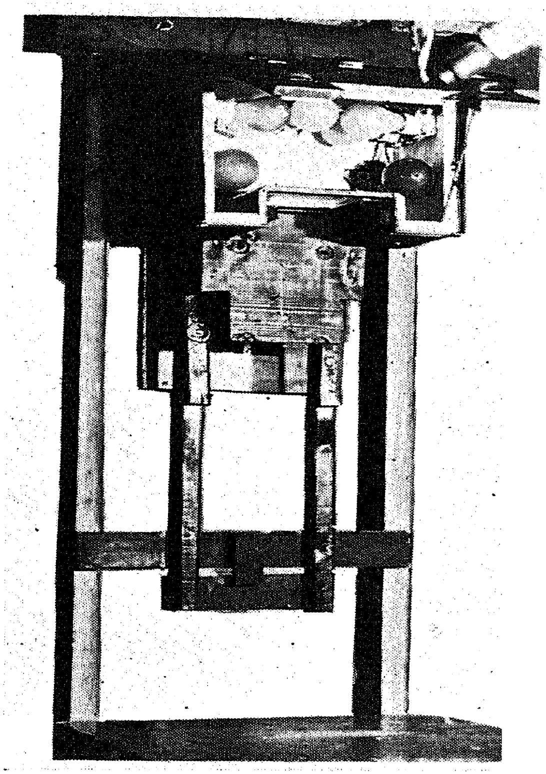


Plate 1

To form a good reflecting surface the inside of the light house should be painted with aluminum paint.

The ventilators, which are of the tin can type previously mentioned, are shown in detail in Fig. 26.

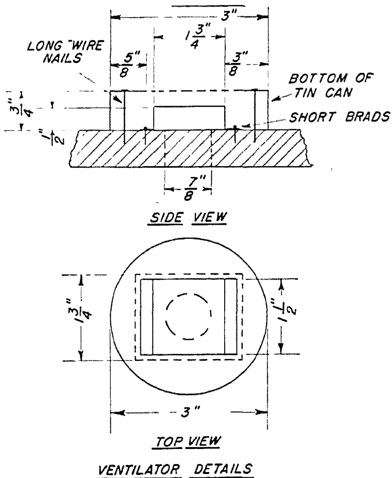
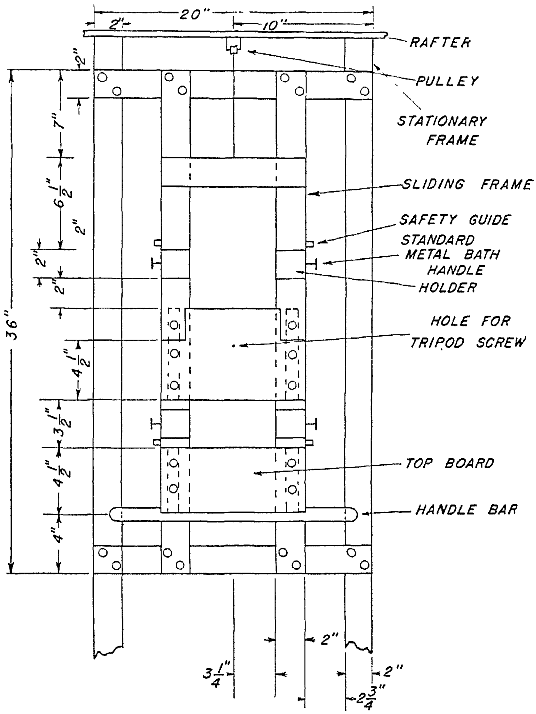


Figure 26

The film holder is again a printing frame, with the back removed. The sides, which are shown in Fig. 24, may be either tin strips which are bent for rigidity, or wood strips. These are fastened far enough below the opal glass to allow the frame to be easily inserted and removed.

The light aperture consists of a frame cut from threeplywood, which supports the opal glass, and which is inlet to prevent the glass from slipping. If desired, a mask may be placed on the glass to decrease the effective aperture.



STATIONARY AND SLIDING FRAME ASSEMBLY

Figure 27

This enlarger was originally designed to take a camera, which was fastened below the negative carrier, but a bellows and lens may be used instead, if the amateur is ingenious enough to construct a practicable device.

Since the construction of the supporting frame, Fig. 27, is somewhat involved, some explanation is necessary. The light house is fastened to a cross bar which, in turn, is part of a sliding frame of 2″ x ¾″ stock. A tripod screw is fastened to the back board in the proper position, determined by experiment, so that the camera will be held close below the light house. The sliding frame is locked to a stationary frame immediately behind it by means of the locking mechanism shown in

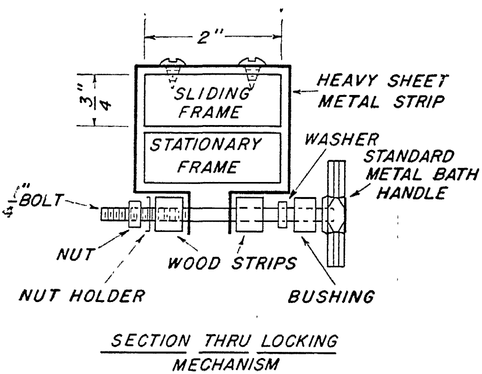


Figure 28

Fig. 28. There are four of these mechanisms to insure a firm lock. It will be seen from the figure that the locking strip on each is fastened to the stationary frame, so that the friction against the sliding frame caused by tightening the handle will prevent motion. If the handle is loosened slightly, the pressure will be decreased enough to allow the projector to move when desired, though still leaving enough friction to prevent it from falling to the bottom of the supporting track. The frames should be lubricated with soap, not oil, since wood absorbs oil.

A pulley fastened to the top of the stationary frame or to a ceiling rafter will permit the use of a rope to counterbalance the weight of the projector. This can be done exactly as in the previous case — by weights in a sack. The handle bar, which aids in raising and lowering the projector, is optional. The safety guides, shown in Fig. 29,

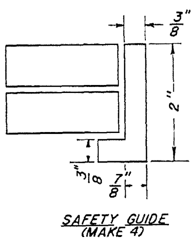


Figure 29

prevent any side motion or jamming of the sliding frame in the locking mechanism. They consist of an L-shaped block fastened to the sliding frame just above or below each locking mechanism.

CHAPTER IV.
TIN CAN ENLARGER

For the amateur who can work better with metal than with wood, quite a few designs are possible. The easiest uses tin cans for most parts, thus removing the necessity for making any complicated pieces. The lens fastenes directly into a tube arrangement, which makes exact calculations for the length of the tubes necessary. For the special case under discussion, we will assume a focal length of

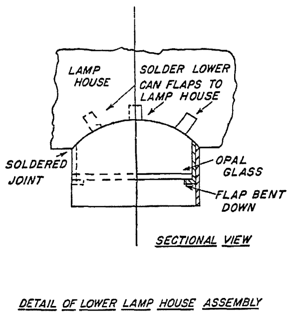


Figure 30

about $2\frac{1}{2}''$. It is intended for miniature roll film, and will not take anything larger than $1''$ x $1\frac{1}{2}''$.

The lamp house consists of a tin coffee can to

which is fastened part of another tin can. The first step is to find the length of the bulb to be used. Cut a hole in the side of the coffee can so that the second can, which should have a diameter of about 3″, will just fit in with the filament of the bulb centered on its axis. The distance from the end to the center of the hole must be determined before the hole is cut.

When this has been done, the 3″ can is cut to fit exactly within the hole, with flaps projecting to allow rigid fastening, as shown in Fig. 30. These

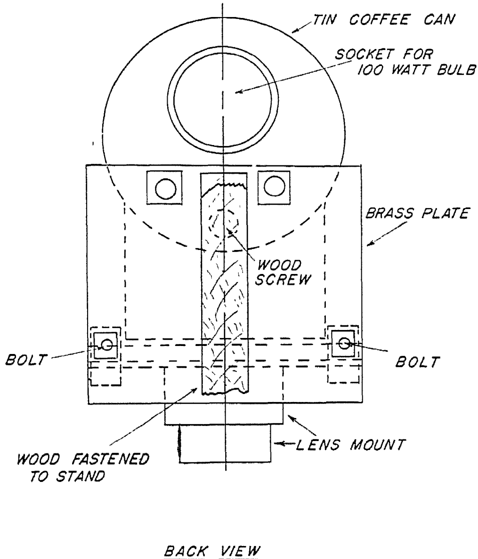
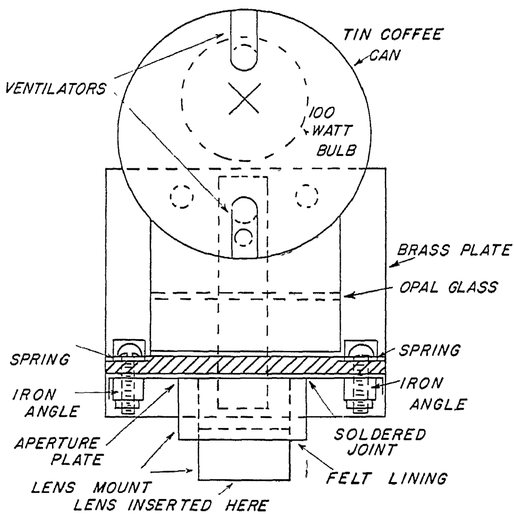


Figure 31

are now soldered firmly together to provide a light-tight joint. Holes are now cut in the bottom of the coffee can to provide openings for the socket, two ¼″ bolts and a wood screw. The position for these can be seen in Fig. 31. When cutting the 3″ can, flaps may be left which when bent, as shown in Fig. 30, will provide opal glass supports, or separate tin pieces may be soldered on. The glass is inserted through the coffee can when the enlarger is completed.



FRONT VIEW

Figure 32

The ventilators for this enlarger of the bent tube type are made of ½″ copper tubing, and fastened on the cover as shown in Fig. 32 and 33. These should be painted dull black inside, to provide a light-absorbing surface.

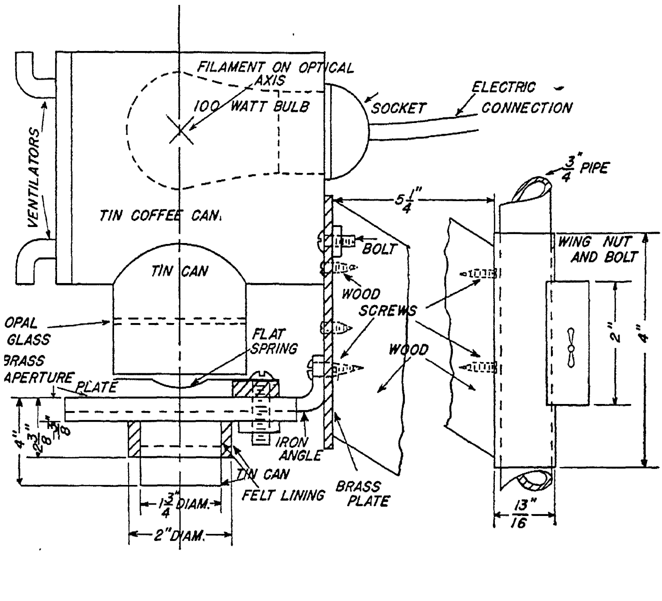


Figure 33

A piece of sheet brass thin enough to be worked easily (about 1/16″) is cut to form a rectangle 4¾″ x 4½″. A rectangular piece 1″ x 1½″ is cut

from the exact center, with the long dimension coinciding with the long dimension of the plate. An apron is now bent over on each side, as shown in the detail in Fig. 34. Holes to take 1/4″ bolts, placed as in the figure, are now drilled in two corners. The distance between these holes must be measured exactly, so that the pieces which will fasten to it can be drilled correctly. Since the

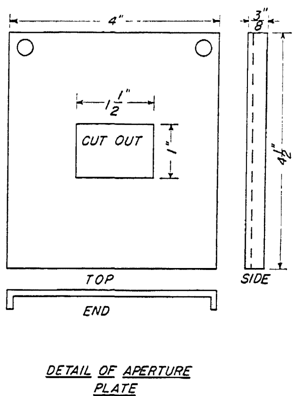
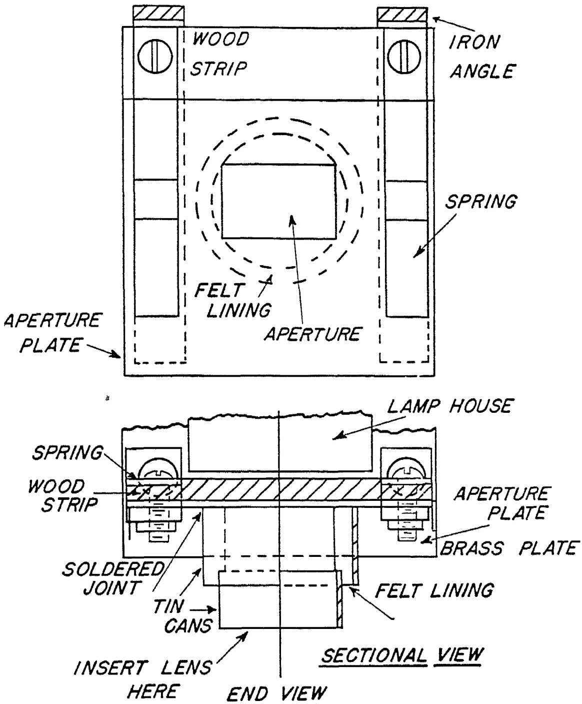


Figure 34

plate is to serve as a mask and negative holder, all edges must be smoothed off and all sharp corners rounded. The apron will project down when the projector is assembled.

To the bottom of this plate is fastened an open-ended cylinder 2 3/8″ long, which has been cut from

a can of 2″ diameter. This is soldered firmly to the plate, with the vertical axis running through the center of the aperture. Next, a brass plate 4″ square is drilled to coincide with the holes pre-



TOP AND END VIEWS OF LENS MOUNT ASSEMBLY

Figure 35

viously put in the lamp house. This should then be fastened loosely in position, first to see if it will fit correctly and secondly, to locate the position of the lower holes which will support the aperture plate and focusing assembly. To locate the center of the holes in which the supporting bolts for the lens holder assembly will be placed, the aperture plate is placed on the 5″ legs of two 3/8″ x 5″ x 1″ angles so that the legs are held against the aprons on the plate, as shown in Fig. 35. This is then held below the lamp house so that there is a space of about 1/2″ between the bottom of the lamp house and the top of the aperture plate. It will be seen from Fig. 35 that there are only two bolts holding the aperture plate to the angles and two holding the angles to the back plate. This is a compromise between positive rigidity and ease of insertion of the negative. It will be firm enough, however, if the bolts are made extremely tight, since the weight of the lens assembly will hold the plate against the iron strips.

A wood strip is cut to fit as shown in Fig. 32, 33 and 35, to provide a spacer for the springs and a stop for the negative carrier. The exact size of this will have to be determined by trial. To this are fastened two brass strips which will serve as springs. These are bent slightly in the center, as

shown in Fig. 33, to provide greater pressure directly over the aperture and thus hold the negative firmly. Holes are drilled in all these parts so that the same bolt will hold spring, spacer, aperture plate and iron angle.

The lower section of the telescoping lens holder is formed from the bottom of a tin can of 1¾″ diameter. This is cut to a length of 2⅝″, and a hole drilled in the exact center of the bottom, which has not been removed, so that the optical center of the lens will be on the vertical light axis of the enlarger. The space between the upper and lower tubes is filled with felt, a layer of which is fastened to the inner side of the upper tube. This layer should be thick enough to prevent mo-

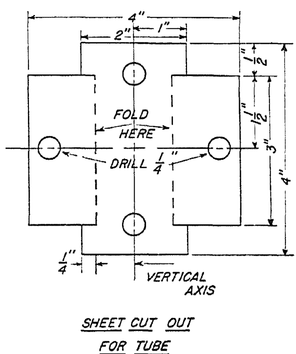


Figure 36

tion of the tube during the exposure, and yet allow accurate focusing.

The brass plate to which all parts of the projector are fastened is, in turn, attached as seen in Fig. 33, to one end of a wood bar 12″ x 3½″ x 1″, both ends of which have been cut at an angle of about 30° to the edges, so that they are parallel

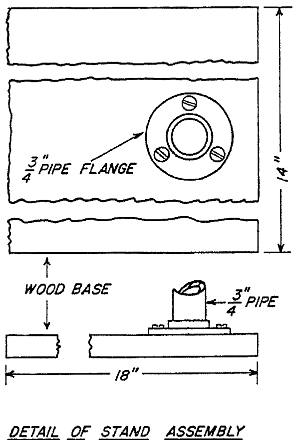


Figure 37

to each other. This angle decreases the stress on the support because of the force of gravity.

The other end of the supporting bar is fastened to a tube which is cut from a piece of aluminum or brass sheet according to the pattern in Fig. 36. The two holes on the vertical axis of the tube

are for the insertion of screws which hold it to the support bar. The tube is then bent around a $\frac{3}{4}''$ galvanized pipe, to give the proper shape, and a $\frac{1}{4}''$ bolt is put through the other holes, which should now be in line. A wing nut serves to hold this in position. When all these parts have been put together, the projector proper is finished and may be painted.

The easel is of the type previously mentioned, and consists of a $\frac{3}{4}''$ galvanized pipe 3 feet long, screwed at one end into a floor flange which is fastened to a board which does double duty as a supporting base and easel, as in Fig. 37. Any type of frame or mask may be used on this, depending on the needs of the builder.

Any dimensions not found in either this text or in accompanying drawings are such that no definite value can be assigned to them and therefore trial and error methods must be used for their determination.

CHAPTER V.

PORTABLE ENLARGER

For those who must travel frequently, or whose space is limited, a portable enlarger is invaluable. It is not difficult to construct and will work admirably for the minicam amateur.

The lamp house is a coffee can of the usual dimensions (5″ long and 4″ in diameter), in which a 60 watt bulb is mounted in a vertical position, with the socket inserted through what was originally the bottom of the can. For ventilation, two pieces of 1/4″ copper tubing are bent and soldered over holes in the can, as shown in Fig. 38. This is satisfactory for a 60 watt bulb, but will not be adequate enough to prevent overheating with a

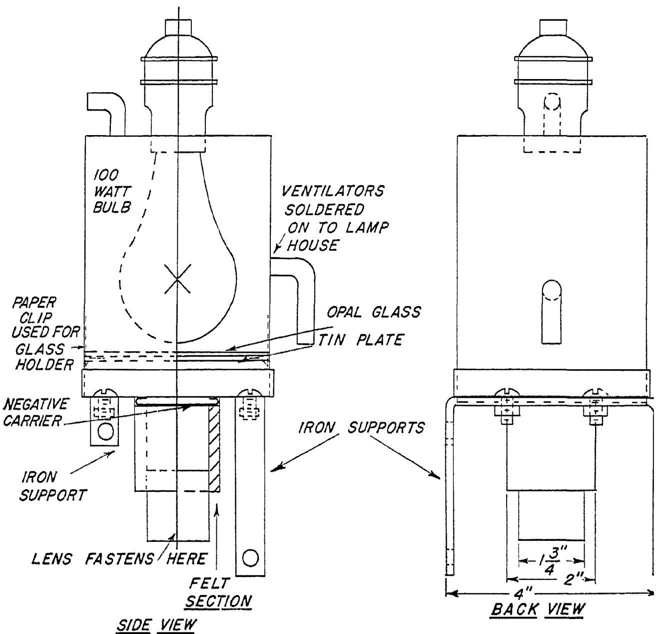
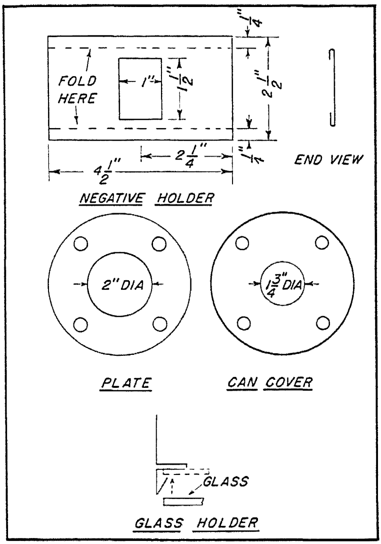


Figure 38

larger bulb. It is therefore important to remember that a larger bulb cannot be used.

The cover of the can and the brass and wood plates to which it will be fastened, are drilled

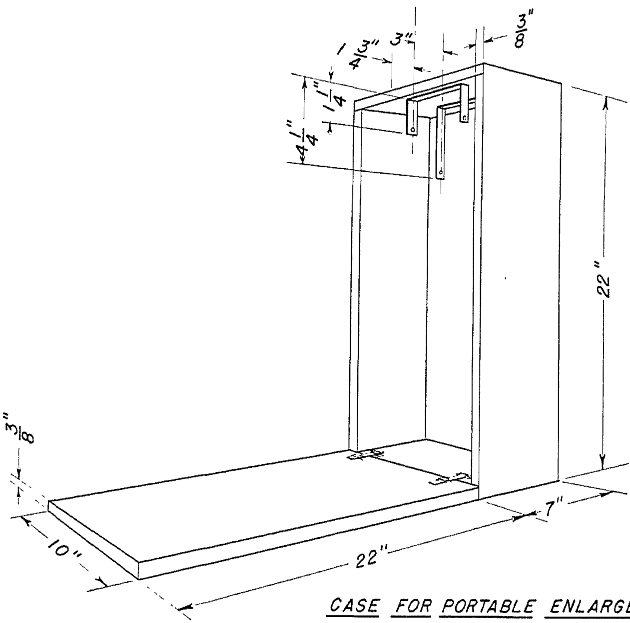


DETAILS

Figure 39

and cut so that the holes will coincide, as shown in Fig. 39. The wood plate is needed to add extra strength to the assembly and insulate the lower section of the projector from the heat generated in the lamp house, while the brass plate provides

a metal surface for soldering the negative carrier and lens assembly in place. The carrier is a track cut from brass and folded as shown in Fig. 39, so that a negative will just slide into the grooves.



CASE FOR PORTABLE ENLARGER

Figure 40

This is soldered firmly to the brass plate. The top section of the lens tube is cut from a tin can 2″ long, and has a length of 2⅜″. It is cut at the

top to fit around the negative track, and also soldered to the brass plate. The remainder of the lens holder is the same as in the enlarger previously discussed.

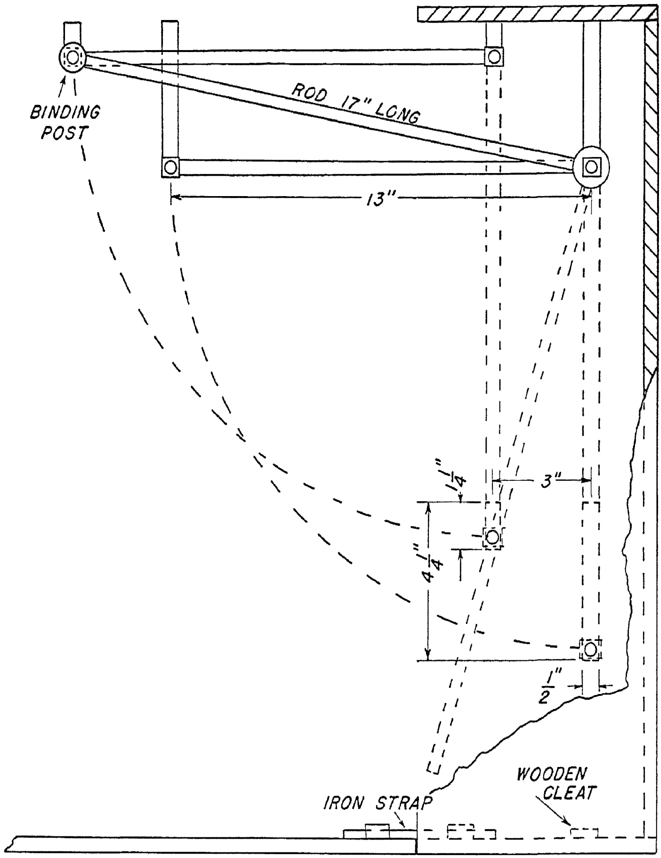
The opal glass supports, which are soldered as near the end of the lamp house as possible, consist of three paper clips bent to the shape shown in Fig. 39, so that the glass may be inserted and held firmly while the enlarger is being carried. There are three of these supports, spaced evenly around the inside of the can. Since the sharp points on the clips might shatter the glass, cut a flat tin disk whose external diameter is the same as that of the glass, making an internal opening which leaves a width of metal of ½″. This, when put under the opal glass, serves as a bearing plate to distribute the pressure of the clips against the glass. There will be just enough spring in the clips to allow removal of the glass and plate when necessary.

The supports for the projector and case are two U-shaped pieces of ⅛″ iron of the dimensions shown in Fig. 40. There are two identical sets: one long and one short strap for the case, and another long and short strap for the projector. These should be interchangeable so that the motion of the projector will be unimpeded. The holes for the sup-

porting rods are $\frac{1}{4}''$ in diameter, centered $\frac{1}{2}''$ from the end of the straps. The straps are fastened to the projector by bolts, as shown in Fig. 38, and to the case by wood screws.

A wood box, 22″ x 7″ x 10″, having the two supporting straps placed as shown in Fig. 40, forms the case. The cover, which is not fastened permanently to the case, is held in position, when carried by hooks on the sides of the case which swing over and catch on nails in the edges of the cover. These cannot be seen in the diagrams. When open, the cover serves as an easel. To prevent the enlarger from tipping over when in use, two bars are put through the straps, which are fastened to the cover and case as shown in Fig. 40. The bars are 4″ long and $\frac{1}{4}''$ thick, and the straps are made of the heaviest sheet metal which can be worked with ease. A wooden cleat is fastened to the inner base of, and placed four inches from the front of the case so that when it is closed for carrying, the bars are held firmly to the base by the strap ,and prevented from sliding out by the cover and the cleat. The cleat can be seen in Fig. 41.

To connect the projector to the case, a system of bars, illustrated in Fig. 41 is used. These are $\frac{1}{2}''$ x 1″ x 13″, and are fastened to the supporting straps by bolts. To allow the upper set of bars to



DETAIL OF SUPPORTING ARMS

Figure 41

move freely without touching the supports for the lower set, they are held out from the connecting straps by ¼″ washers at each bolt. To hold the projector in any position, two rods 17″ long are bent at one end to form an eye, and fastened to the bolts holding the lower set of bars to the long strap in the case, as shown in Fig. 41. The other end of rods pass through binding posts, such as are used in electrical work, which are bolted to the short straps and bars on the projector. These bolts must be loose enough to turn as the projector is moved up and down, so that the rods will not be locked in one position. By tightening the hand screws in the binding posts, the rods are prevented from sliding, and thus hold the projector in a true vertical position, these sliding rods and fastener supports must be on both sides.

The dimensions of the supporting and bracing bars and rods must be exactly as given, since the slightest change in any one part will necessitate a complete recalculation of all other dimensions, if the system is to work correctly.

CHAPTER VI.

ADVANCED CONSTRUCTION

A vertical enlarger (Plate 2.) which deserves the title of hand-made instead of home-made because of the craftsmanship used in constructing it, can be built by the more skilled workman. To prevent confusion in the plans, the parts, when mentioned in the text, have been numbered (Piece - -) to correspond with the list below.

1. shade holder	16. heavy eye
2. chimney	17. ¼″ line
3. ⅜″ brass pipe	18. pulley
4. light support	19. wall support
5. reflector	20. wall spacers
6. double light socket	21. frame
7. 60-watt lamp	22. transom lock
8. lamp house	23. easel
9. opal glass	24. 6″ x 8″ bracket
10. ground glass	25. sliding frame
11. ventilator	26. wall brackets
12. light box	27. sliding guide plates
13. negative carrier	28. reel brackets
14. camera carrier	29. reel pins
15. camera	30. reel handle

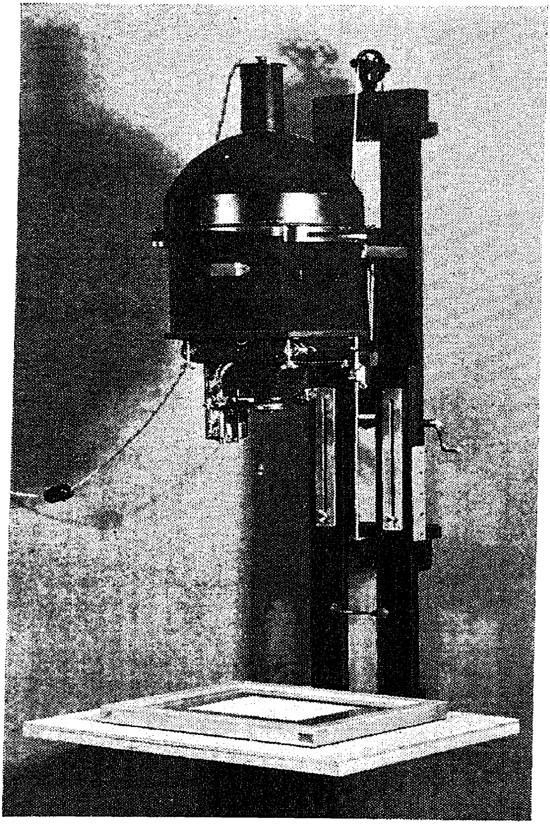


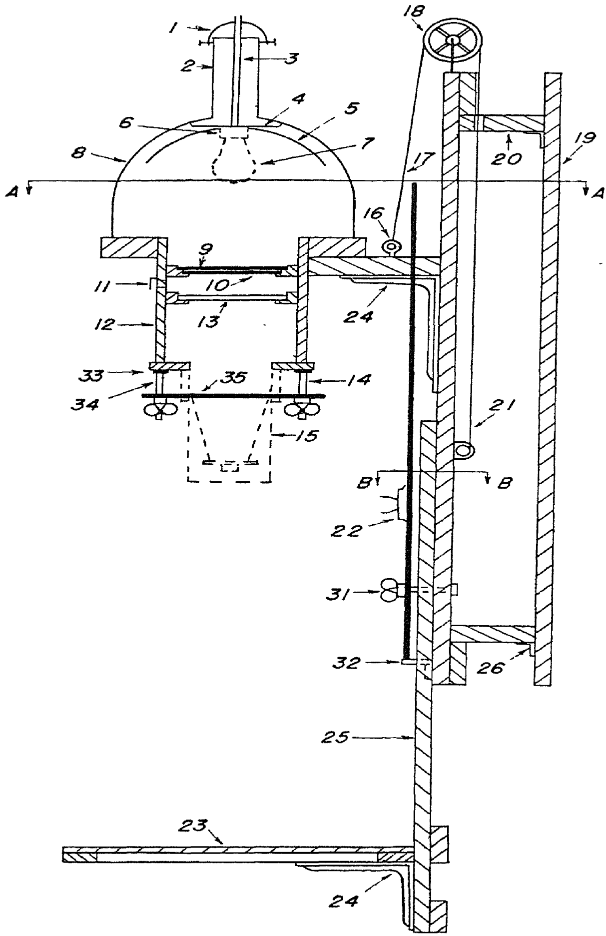
Plate 2

31. carriage bolt	34. ¼″ bolt, length to suit
32. rod support	35. bearer
33. retaining plates	36. sliding clips

All wood used is white pine. The vertical bars to which the projector and extension bars are fastened, Fig. 42, are ¾″ x 2¾″ x 42″ long. They are spaced 2¾″ apart on the inner edges with a ¾″ x 2¾″ x 8″ cleat across the top, as shown in Fig. 42, and fastened with 1¼″ No. 8 roundhead screws. The inner edges of these vertical bars must be perfectly parallel.

The vertical supporting bars of the extension are similarly spaced and secured but at the bottom end only. A ¼″ x 11″ slot is cut down the center of these bars, beginning 2″ from the top end. These slots are faced with a sheet metal plate which is 1½″ x 12″ x 1/32″ thick with a ¼″ x 10½″ slot down the center (two metal strips can be substituted for each of these plates) and secured in place with ½″ No. 4 flathead screws. Two ¼″ x 2″ carriage bolts, Piece 31, are forced into holes slightly smaller than the diameter of the bolt, 1″ below the bottom end of each slot in the bars. A wing nut is provided for each of these bolts, which, because of the forced fit will not turn.

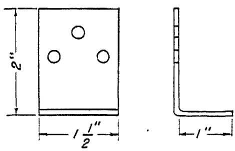
The bed or easel, is 18″ x 24″ made with a



SIDE SECTION

Figure 42

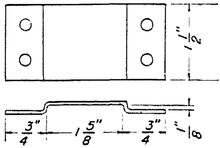
border frame and an additional piece across the center opening from front to back, all of ¾″ x 1¾″ strips, doweled and glued together and covered with a piece of plywood ⅜″ thick. This assembly is fastened to the extension by two blocks and an angle iron, which serve effectively to prevent motion or bending of the easel because of the weight of a printing frame on it.



WALL BRACKET

Figure 43

Spacer bars, Piece 20, extending the enlarger from the wall supports, are 4¼″ x 8″ x 1″ thick, secured to verticals with 1½″ No. 10 flathead screws. The wall supports, Piece 19, are ¾″ x 3¾″

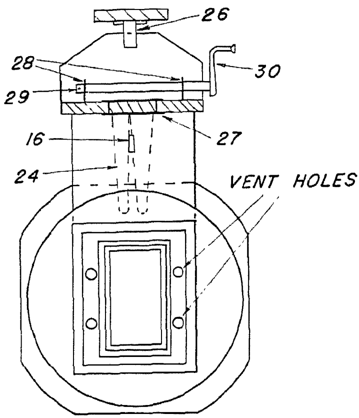


WALL CLIP

Figure 44

x 42″ long, secured to the wall with two screws in each end.

The wall brackets shown in Fig. 43, Piece 26, are 1½″ wide by 1/16″ thick, bent 90°, with the clip leg 1″ long and the other 2″ long. These brackets hook into the wall clips, Fig. 44, which are 1″ x 1/16″ thick, flanged to receive the 1″ x 1/16″



SECTION THRU AA

Figure 45

ends of the brackets and are secured to the wall strips with two ¾″ No. 8 roundhead screws in each end.

The reel, seen in Figs. 42 and 45, is ½″ brass

pipe 7″ long, supported in sheet metal brackets, Piece 28, at each end. The brackets are bent 90° and secured to the enlarger verticals with 3/4″ No. 6 roundhead screws. 1/8″ pins, Piece 29, are located in the pipe as shown. The crank, Piece 30, is a Ford car window handle riveted onto the end of a pipe. The line, Piece 17, is 1/4″ braided cord. A 5/16″ diameter hole is drilled through one wall of the pipe, about 1½″ from the center, to secure the end of the line with a knot on the inside of the pipe. The upper end of the line is secured to a stout screw eye, Piece 16, fastened to the wooden lamp house support. The line runs over a pulley, Piece 18, which has wheel about 3″ in diameter.

The support which holds the lamp house from

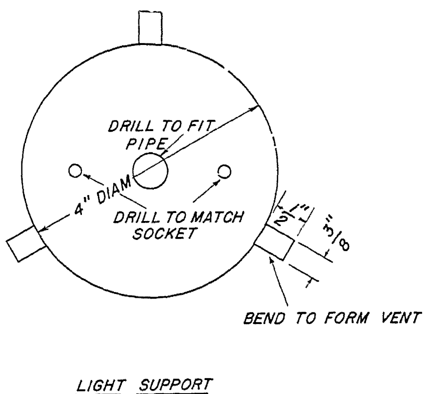


Figure 46

the vertical bars, as seen in Figs. 42 and 45, is 6½″ x 7″ x 1″ thick, secured to a ¾″ x 2¾″ x 16″ slide and supported on two 6″ x 8″ iron brackets, Piece 24, which are also secured to the slide with screws. The slide is held in place by four 1¼″ x 3¾″ x 1/16″ thick guide plates Piece 27, which are secured to the slide with ¾″ No. 6 roundhead screws. A thickness of paper must be put under the top of the front and bottom of the rear strap to permit the slide to operate freely.

The lamp house, Piece 8, is 12″ in diameter and 8″ high, not including the bottom of the vent. It can be made in any shape and of any kind of sheet metal handy, although a parabolic form is recommended. The light support plate, Piece 4, shown in Fig. 46, is 4″ in diameter with lugs ⅜″ x ½″ long. These lugs are bent up to create a vent space. The plate is soldered to the bottom end of the ¼″ brass pipe, Piece 3. The top end of this pipe is threaded and provided with a shade holder, Piece 1. This pipe supports the reflector, Piece 5, which is an automobile headlight reflector. If it is not chromimum-plated, it will have to be lacquered to prevent tarnishing. The pipe also supports the double light socket, Piece 6, and two 60-watt "White Way" enlarging lamps, Piece

7. The wiring to the lights leads through this pipe.

The positive stop, Pieces 22 and 32, shown in Fig. 47, is made from a $3/8''$ x $36''$ Commercial

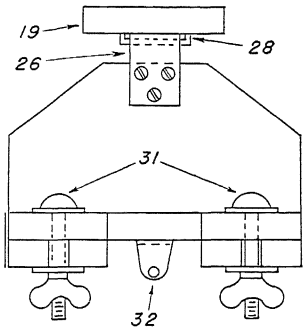
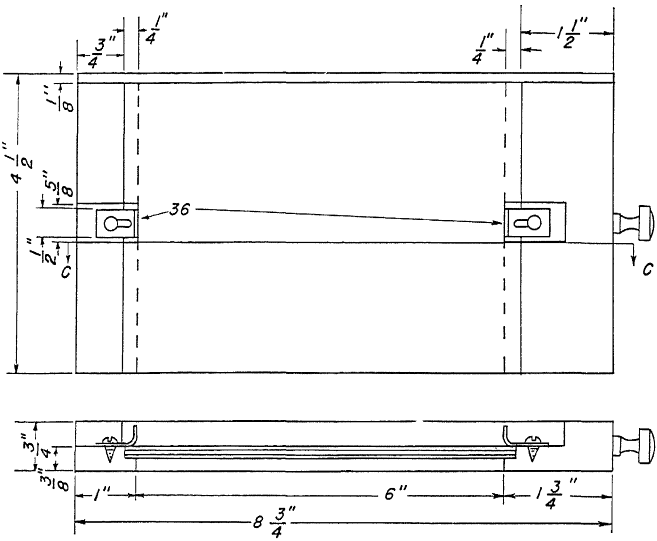


Figure 47

transom adjuster whose length is cut to suit the needs of the enlarger.

The light box is $9''$ across the front, by $7\,3/8''$ x $9''$ high, outside dimensions. It is made of wood $5/8''$ thick with a light aperture $4''$ x $6''$ in the bottom. The opal glass, Piece 9, $4\,3/8''$ $6\,3/8''$, and the groundglass, $4''$ x $6''$, are located $2''$ below the top of the light box and spaced $1/4''$ apart. Four $3/8''$ holes are made in the frame for ventilation, as shown in Fig. 45.

The negative carrier is made as shown in Fig. 48, and located ¾″ below the ground glass frame. Sliding clips, Piece 36, which can be adjusted to suit the thickness of glass used, hold in place



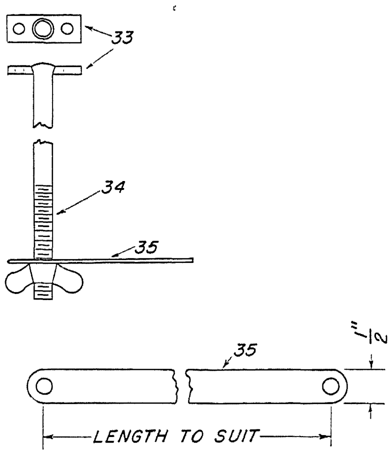
SECTION THRU C–C

NEGATIVE CARRIER

Figure 48

the two 4″ x 6″ thin glass sheets between which the negative is placed and held flat. The four ¼″ x 2⅜″ studs, Piece 34, are secured to ½″ x 1″ x

1/16″ plates, Piece 33, which are in turn fastened to the light box by ½″ No. 6 roundhead screws. Wing nuts are provided for each of the studs. The bearer supporting the camera, Piece



CAMERA MOUNT ASSEMBLY

Figure 49

35, shown in Fig. 49, is ⅝″ x 6¼″ x 1/16″ thick, of hard brass, with 5/16″ holes in each end spaced to match with the studs. The two ventilators, Piece 11, each cover two ½″ diameter holes in the light box. They are made of thin sheet metal and are open on the bottom end only.

The camera, Piece 15, is in this case a 3-A

Kodak with an *f* 6.3 lens. Small blocks are fitted on the bottom end of the light box to fill the open ends of the camera. Of course, any camera that can be fitted to a flat surface may be used. A 4″ x 5″ or 5″ x 7″ view camera would prove ideal, although negatives from the latter would not fit in the enlarger.

CHAPTER VII.
METAL ENLARGERS

A metal enlarger (Plate 3.) which is also a demonstration of skill, can be made by the amateur with the proper tools, although a tinsmith may be needed for the more complicated parts. It is designed for a 2¼″ x 3¼″ negative, and takes a 4⅜″ focal length lens. Instead of diffusers, a single condensing lens is used. The condenser is in a helical mount, which allows the lens to move down to the negative, thus eliminating the necessity of having a piece of glass between the film and the camera lens. This feature helps prevent dust and lint from showing on the print.

Plate 4 shows the condensing lens and holder. The holder is turned from a pipe coupling. The lens is 4½″ in diameter and may be purchased from any photographic supply house for a dollar or two. It is held in place by a small wire soldered to the inside edge of the holder. If the edge of

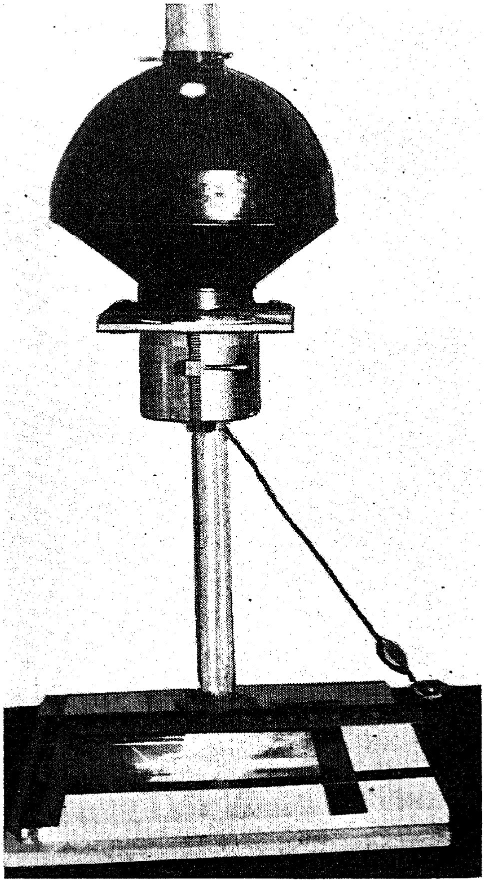


Plate 3

the lens is beveled, the small wire ring will hold it and allow its plane surface to project slightly beyond the edge of the holder, thus permitting the flat side of the lens to come in contact with the negative. The ring or collar shown in Plate 4

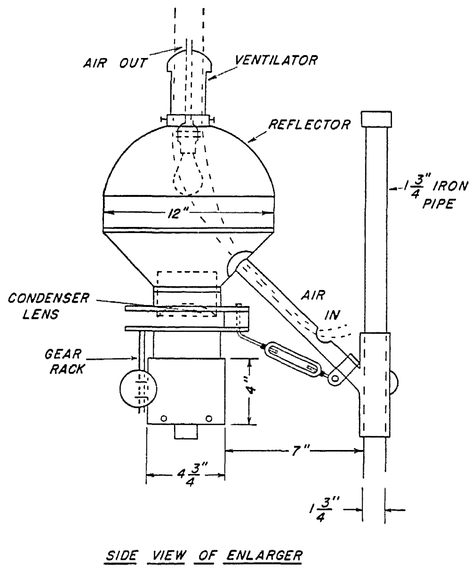
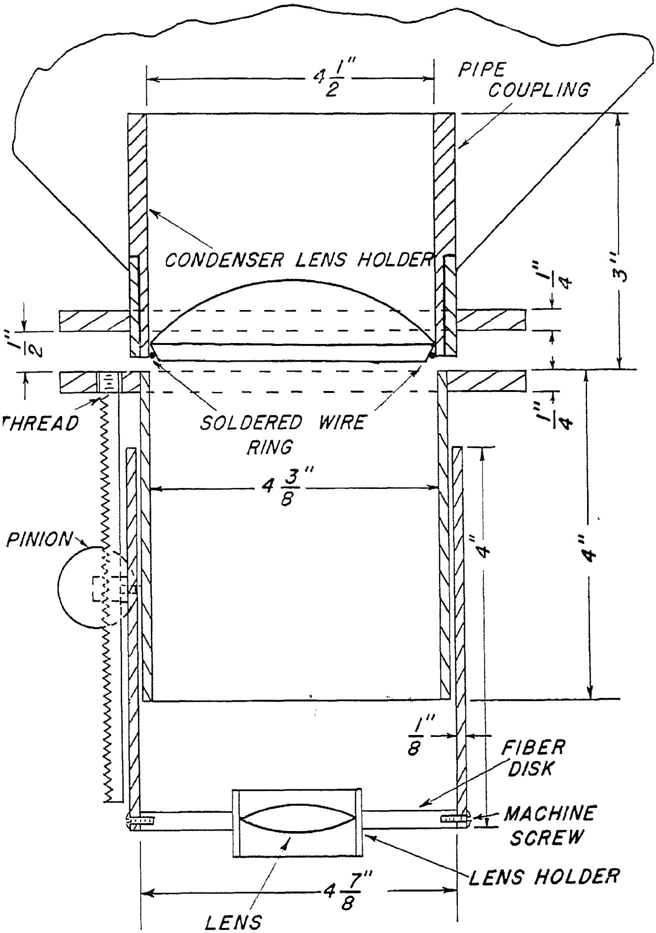


Figure 50

slides over the end of the lens holder. As this ring is rotated in the spiral grooves cut in the sides of the lamp house, the condenser moves down, thereby holding the negative flat against the metal mask.



DETAIL OF FOCUSING ASSEMBLY

Figure 51

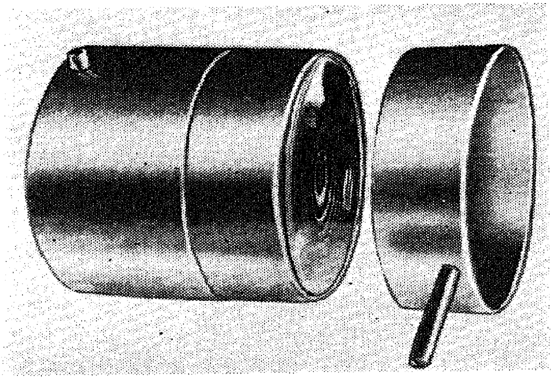


Plate 4

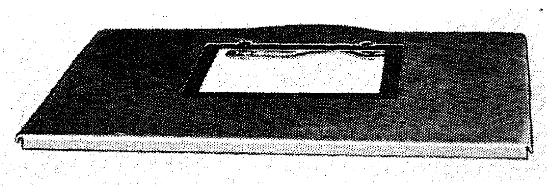


Plate 5

Plate 5 pictures the mask or negative carrier. With this type of carrier individual films may be used. They be left in the roll uncut and put through the enlarger that way or else they may be cut and used separately.

Fig. 50, the sideview of the enlarger, gives the dimensions. The baseboard, shown in Plate 3, is a piece of ¾″ plywood 18″ x 24″. The upright is a 1¾″ O. D. galvanized iron pipe fastened to the baseboard by means of a floor flange. The projector itself is made in three units: the reflector, the lamp house and the bellows. The bellows is

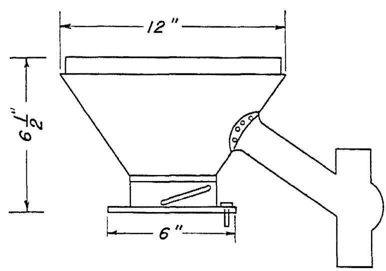


Figure 52

made of two telescoping aluminum tubes. The inner tube is threaded into a ¼″ plate of cold rolled steel, 6″ x 8″. The end of the rack, which adjusts the focus, is also threaded and fastened

to this lower plate, with just enough clearance to allow the outer tube to slide between it and the other tube. The pinion gear and housing are fastened to the outer or lower tube from the inside by means of counter-sunk screws. This permits the racking of the lower tube in or out, forming the bellows. The lens holder is a 1/4″ disk of fiber, the inside diameter of the outer tube, fastened to the end of the tube by four machine screws.

The lower lamp house assembly, Fig. 52, was made by a tinsmith out of 16 gauge tin and black iron. The inner section (Plate 6) is made to hold the condensing lens mount, Plate 4, as shown in Plate 7. This assembly was made to fit an old reflector which was picked up in a second hand store for a dollar. To the lower part of this assembly is soldered the other 1/4″ plate of cold rolled steel. The two assemblies are bolted together at the back with a 1/2″ spacer bar in between. The lamp house assembly has a flange on it, allowing the reflector to slide over it and fit snugly.

The ventilation system is shown by the dotted lines in Fig. 50. The light socket is threaded on a piece of 1/8″ iron pipe and is held in place, though adjustable, by means of three set screws at the top of the reflector. The turnbuckle serves two purposes: first, as a brace and secondly, as

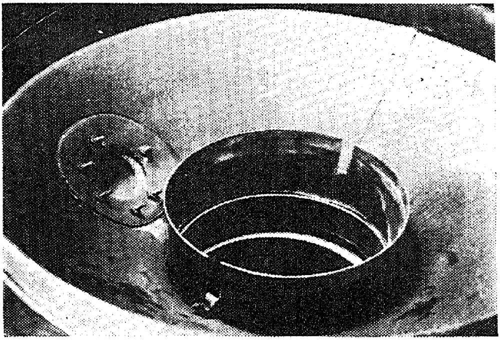


Plate 6

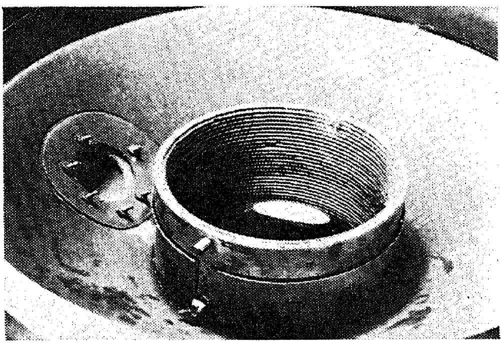


Plate 7

an aid to adjusting the enlarger and insuring that the negative is in the same plane as the easel. The arm supporting the lamp house has a hole cut in it for the purpose of ventilation. The ventilator contains baffles to prevent light leaks. The cap on the ventilator is a lampshade holder, of the type which is made to hold the shade to the fixture. This can be purchased in any electrical or hardware store. The bulb is a 100 watt frosted type.

COST OF MATERIAL

1 $\frac{3}{4}''$ plywood baseboard $18'' \times 24''$	$ .45
1 $1\frac{3}{4}''$ O. D. floor flange and galv. iron pipe $34''$ long	.60
1 lamphouse assembly (made by tinsmith)	3.50
2 pieces of aluminum tubing (Aluminum Co. of Amer.)	2.00
2 pieces $\frac{1}{4}''$ cold rolled steel plate $6'' \times 8''$	.50
1 turnbuckle	.25
1 rack and pinion gear 20 pitch (Chicago Gear works)	1.90
1 condenser lens $4\frac{1}{2}''$ (Burke & James)	1.50
1 reflector	1.00
TOTAL	$11.70